PART 10B

PARTICULAR TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL AND CONNECTED WORKS

CONTENTS

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PART-10B

PARTICULAR TECHNICAL SPECIFICATIONS/REQUIREMENTS FOR CIVIL, STRUCTURAL AND CONNECTED WORKS

A. Standard Basic Specifications

The "Standard Basic Specifications for Civil, Structural and Connected Works for Sewage Treatment Plants Contracts" Part-10A issued by the BWSSB, set out the specifications that shall be followed for construction of General Works under this contract. Specifications for additional specialized items of civil, structural and connected works are as set out in Part 10B, Particular Technical Specifications, of this Section.

In the event of any discrepancy between the provisions of the Standard Basic Specifications and the Particular Technical Specifications, the provisions of the Particular Technical Specifications shall prevail.

B. Particular Technical Specifications for TTP & Connected Works

1.0 Design Submissions

Before proceeding with design and drawing preparation, the Contractor shall submit detailed general philosophy of design (Design Basis Report) of various parts of (all) the structures and equipment foundations along with explanatory sketches for review. Only after the review and incorporation of comments on the general philosophy, as offered during the review, the Contractor shall submit any design document and/or drawing for review and approval for construction.

1.1 Design Philosophy

Following are the details which are to be included in the general design philosophy document submission:

1. Design assumptions/philosophy for Liquid Retaining Structures with various boundary conditions as applicable
2. Design assumptions/philosophy for buildings
3. Design assumptions/philosophy for all other structures
4. Standard General Notes shall include material properties (grade, strength, unit weight etc.), development lengths, lap/splice lengths, Anchorage lengths under tension and compression, clear cover, water proofing specifications, legend used etc.

1.2 Standard Details

Following typical details shall also be submitted for approval prior to proceeding with detailed design:

1. Reinforcement detail showing the development length at Column/Footing intersection, Column and Roof beam intersections, Walls and Base slab intersections, Walls and cover slab intersections.
2. Detailing of the reinforcement for columns, beams, beam/column intersection, footing/column intersection, and Slabs as per relevant code provisions/requirements depending upon the assumptions made in the design as applicable.

3. Reinforcement detail for cut-outs in slabs and walls with maximum size of cut-outs
4. Reinforcement detail at top of RCC trench walls showing edge/seating angles
5. Pouring sequence of concrete and standard details for construction joints, expansion joints, contraction joints, etc.
6. Details of Opening/Manholes and Rungs to be placed in the tanks
7. Detail for rain water drainage down takes at terrace slab and water proofing at roof/sunken slabs
8. Detail for storm water drain, Roads, plinth protection and entrance ramps to buildings
9. Detail for Handrails and fixing detail of handrail to concrete, Steel Ladders and fixing detail of ladders to Walls/Concrete, Cage ladders, Boundary walls, Fencing and Gates, etc.,
10. Material specifications and application methodology for Anti-Corrosive Internal coating/Lining protection of concrete surfaces.

1.3 Submission

Contractor shall submit the detailed design and drawings only after items mentioned under clause 1.1 and 1.2 are approved or as directed by the Engineer

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Engineer. Separate design calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and shall not be accepted by the Engineer.

Submissions of detailed design calculations and Good for Construction drawings shall include the following as a minimum:

A. Detailed Design Calculations
    1. One (1) Copy of a Compact Disc (CD) containing electronic files relevant to the structure's modelling, analysis and design calculations (Microsoft Excel, STAAD Pro, etc.). **All Files submitted shall be in editable format.**
    2. Print copy (5 Copies) of the contents as submitted in the Compact Disc.

B. Good for Construction Drawings
    1. One (1) Copy of a Compact Disc (CD) containing AutoCAD files (Civil General Arrangement, Structural Dimensions and Reinforcement Details) pertaining to the structure. Files submitted shall be in editable format.
    2. Print copy (5 Copies) of the contents as submitted in the Compact Disc. Prints to be submitted on A1 Size Sheet as a minimum or A0 Size Sheet when required by the employer.
    3. Bar-bending schedule indicating the number, shape and size of the rebars shall be submitted as part of the Reinforcement Details.
    4. Detailed drawing showing the location, number and depth of inserts shall be included for any structural steel inserts/Metal inserts in the structure such as rungs, bolted connections for ladders/railings, etc.
    5. Location of Construction Joints and pour sequence shall be included on the drawing for base slabs, walls and top slabs.

6. Revised drawings shall be submitted by clouding at the location with the latest revision number and also show the history of revisions in a table format just above the title block.

The design considerations described here under establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

1.4 Design Standards

All the designs shall be based on the latest Bureau of Indian Standard (BIS) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other International Standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by the Engineer. In case of any variation or contradiction between the provisions of the BIS Standards or Codes and the specifications given along with the tender document, the provision given in this Specification shall be followed.

All reinforced concrete structural design shall generally conform to the following recently published publications of the Indian Standards Institution:

IS:456 : Code of Practice for plain and reinforced concrete
IS:875 : Code of Practice for design loads for buildings and structures (Part I to V)
IS:3370 : Code of Practice for concrete structures for the storage of liquids (Part I to IV)
IS:1893 : Criteria for earthquake resistant design of structures (Part 1to 4)
IS: 2974 : Code of Practice for design and construction of machine foundations (Part 1 to 4)
IS: 2911 : Code of practice for Design and construction of Pile foundations. (Parts 1 to 4)
IS:13920 : Ductile Detailing of Reinforced Concrete Structures subjected to Seismic forces-Code of Practice.
IS: 4326 : Code of Practice for Earthquake Resistant Design and Construction of Buildings
IRC: 6 : Standard specification and Code of Practice for road bridges Loads and Stresses
SP: 16 : Design Aids for Reinforced Concrete to IS 456
SP: 34 : Handbook on Concrete Reinforcement and Detailing.
SP: 23 : Handbook on Concrete Mixes.

All structural steel design shall generally conform to the following recently published publications of the Indian Standards Institution:

I.S: 800 : Code of Practice for general construction in steel
I.S: 806 : Code of Practice for use of steel tubes in general building construction
SP: 38 : Handbook of Typified Design of Structures with Steel Roof Trusses

1.5 Design Life

The design life of all structures and buildings shall be 60 years.

1.6 Design Loadings

All buildings and structures shall be designed to resist the worst combination of the following loads/stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads.

1.7 Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment's and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included, but excluding contents, shall be considered.

Dead loads shall be in general as per I.S. 875 Part (I). However, the following **minimum loads** shall be considered in design of structures:

(i)	Weight of water	10.0 kN/m^3
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered	20.00 kN/m^3
(iii)	Weight of concrete	24.00 kN/m^3
(iv)	Weight of reinforced concrete	25.00 kN/m^3
(v)	Weight of brickwork (exclusive of plaster)	22.00 N/m^2 per mm thickness of brickwork
(vi)	Weight of Solid Concrete Block work (exclusive of plaster)	24.00 N/m^2 per mm thickness of block work
(vii)	Weight of plaster to masonry surface	18.00 N/m^2 per mm thickness
(viii)	Weight of granolithic terrazzo finish or rendering screed, etc.	24.00 N/m^2 per mm thickness
(ix)	Weight of sand (filter media)	26.0 kN/m^3
(x)	Weight of alum blocks	24.20 kN/m^3
(xi)	Weight of MS chequered plates	78.5 N/m^2 per mm thickness of plates

1.8 Live Load

Live Load (LL) shall include the superimposed loads due to the use/occupancy of the structure/building not including dead, wind or earthquake load. Live loads shall be in general as per I.S. 875 Part (II). However, the following **minimum live loads** shall be considered in the design of structures:

(i) Live load on roofs (accessible by staircase) : 1.50 kN/m^2

(ii) Live load on floors supporting equipment such as pumps, blowers, compressors, valves etc. : 10.00 kN/m^2

(iii) Live load on all other floors walkways, stairways and platforms : 5.00 kN/m^2

(iv) Live load on Toilet areas : 2.00 kN/m^2

(v) Surcharge for underground structures
Including channels, sumps, cable & pipe trenches etc. : 20.00 kN/ m^2

In the absence of any suitable provisions for live loads in BIS Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Engineer prior to starting the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during maintenance or erection/construction shall be considered and shall be partial or full whichever causes the most critical condition.

1.9 Wind Load

Wind loads shall be as per I.S. 875 Part (III).

1.10 Earthquake Load

This shall be computed as per I.S. 1893. An importance factor appropriate to the type of structure shall be considered for design of all the structures. **For design of all Process buildings and structures an importance factor of 1.75 shall be adopted.**

1.11 Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of foundation of such structures. As a guide, the mass of the foundation should be at least 2.5 times the mass of the whole machine or as provided by the manufacturer/Vendor for dynamic analysis.

1.12 Vehicular Wheel Load

For any structure or pipeline below the roads, Class A loading of IRC 6 shall be considered.

1.13 Joints

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However, contraction joints shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than **30 m** shall be provided in walls, floors and roof slabs of liquid retaining structures and not more than **45m** for buildings.

Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction.

To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2 m height. All expansion and construction joints of water retaining structures and underground structures in RCC shall be made water tight using PVC water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and 150mm width shall be used for walls and 230mm width for base slabs.

Two part poly sulphide sealant conforming to IS: 12118 shall be used for sealing of all joints. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler.

1.14 Design Criteria for Underground or Partly Underground Liquid Retaining Structures

Water level is assumed at the ground level for design of all the structures. All underground or partly underground liquid containing structures shall be designed for the following conditions:

(i) Liquid depth up to full height of wall: no relief due to soil pressure from outside to be considered.

(ii) Structure empty (i.e., empty of liquid, any material, etc.): full earth pressure and surcharge pressure wherever applicable, to be considered.

(iii) If water table exists, earth pressure to be considered for submerged soil conditions with reference to geotechnical recommendations, approved by the Engineer.

(iv) Partition wall between dry sump and wet sump: to be designed for full liquid depth up to full height of wall.

(v) Partition wall between two compartments: to be designed as one compartment empty and other full.

(vi) Structures shall be designed for uplift in empty conditions with the water table considered at FGL. Minimum factor of 1.2 shall be ensured against uplift or floatation.

(vii) Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads (Hydrodynamic Impulsive Pressure).

(viii) For general retaining walls and large sized tanks where the walls are designed as retaining walls, sliding check shall also be performed along with over turning checks.

Overturning: The stability of a structure as a whole against overturning shall be ensured so that the restoring moment shall be not less than the sum of 1.2 times the maximum overturning moment due to the characteristic dead load and 1.4 times the maximum overturning moment due to the characteristic imposed loads. In cases where dead load provides the restoring moment, only 0.9 times the characteristic dead load shall be considered. Restoring moment due to imposed loads shall be ignored.

(ix) **Sliding:** The structure shall have a factor against sliding of not less than 1.4 under the most adverse combination of the applied characteristic forces. In this case only 0.9 times the characteristic dead load shall be taken into account as per IS codes.

(x) Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The stability of the structure should be checked against uplift using Factor of safety of 1.2. The individual members shall be designed for stresses due to uplift forces.

(xi) All the liquid retaining structures shall be design for maximum design crack widths of 0.1mm for direct tension and flexure.

(xii) In case of Large and Deep Underground Tanks, the analysis can be carried by Finite Element Method using STAAD Pro or any other equivalent software predominantly used and accepted in the industry.

1.15 Foundations

(i) The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be as per IS 1904 but in any case this shall not be less than 1.0 meter in the original soil.

(ii) Maximum safe bearing capacity of soil strata shall be taken as determined by the Bidder through his own independent investigations. Geotechnical reports of proposed sites covered under the contract are available with the employer for reference. It may be used by Contractor as part of, in addition to, or in lieu of such investigations at his own risk.

(iii) The Bidder shall ensure the technical feasibility of the offer submitted after visiting the sites and conducting independent investigations. It must be clearly understood by the bidder that as the contract is Design, Build and Operate, the contractor shall be required to design and execute every such item(s) of work(s) which are considered required or necessary for the satisfactory completion and functioning of the entire work, commissioning of electro-mechanical equipment, Instrumentation, SCADA systems, trial run and operation and maintenance, and any other items required but not specified in the bid document, but are essential to complete the scheme. Nothing extra or additional shall be paid to the contactor on account of his failure of understanding.

(iv) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.

(v) Special attention is drawn to danger of uplift being caused by the ground water table level considering at FGL. All underground structural slabs shall be designed for uplift forces due to ground water pressure.

(vi) EGL (Existing ground level) and FGL (Finished ground level) shall be marked on all drawings showing foundation/sub-structure details and related design documents.

(vii) Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.

(viii) Foundations and structures for machines subject to vibrations shall be so proportioned that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).

(ix) Machine foundations shall be designed and detailed as per IS: 2974. All appendages to such foundations shall be reinforced suitably to ensure integral action.

(x) Pile Foundations - Design, Testing and Execution of piles shall be considered as per provision of relevant codes (conforming to latest version of IS: 2911), and in compliance with the Geotechnical report recommendations as applicable.

(xi) Foundations for plant structures in Swampy/Waterlogged areas, for lightly & medium loaded structures and relevant Ground Improvements shall be considered in compliance with the relevant Geotechnical Investigation Report recommendations as applicable. Also to enlist the services of an experienced & specialized agency for all related design aspects considerations, equipment specifications, and implementation methodology, etc., as an advice for the same.

1.16 Design Requirements

The following are the design requirements for all reinforced or plain concrete structures:

a) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade M10 with a maximum 10mm aggregate size.

b) All liquid retaining reinforced concrete structures, concrete shall be of a minimum M30 grade with a maximum 20mm aggregate size for all structural members and for Buildings, shall be of a minimum M25 grade (Footings, Plinth Beams, Columns, Slabs and beams, etc., i.e. which are other than liquid retaining structures) with a maximum 20mm aggregate size of all structural members. Further, if there are any liquid retaining RCC tanks coming up with in the buildings, concrete shall be of minimum M30 grade for such RCC tanks also.

c) All process buildings shall be with reinforced concrete structures with RCC roof slab and covered all around.

d) The reinforced concrete for all liquid retaining structures shall have a minimum cement content of **400 kg/m^3** for M30 grade concrete and building structures shall have minimum cement content of **360 kg/m^3** with M25 grade concrete. Reinforced concrete shall have maximum slump of 100 mm and maximum water cement ratio of 0.48.

e) The minimum clear cover to all reinforcement including stirrups and links shall be 60 mm for all liquid retaining structures except for Launders/Gutter Slabs cover shall be 45mm.

f) As a design consideration to control crack, though general requirements of IS 3370 shall be followed, permissible crack width shall be limited to 0.1 mm for all liquid retaining structures and other limit state requirements also to ensure an adequate degree of safety and serviceability.

g) The minimum amount of reinforcement in each of the two directions at right angles within each surface zone should be provided as per clause 8.1 of IS 3370 (Part 2):2009. Definition of surface zones is clearly shown in Figure 1 and Figure 2 of IS 3370 (Part 2): 2009. For slabs, minimum of 10 mm dia. bars shall be used to avoid any deformation of lesser diameter bars under loads prior to construction. Any liquid retaining structures which are more than 165mm thickness shall have reinforcement on both the faces.

h) The minimum cover to the main reinforcing bars for different members

1. Non–liquid retaining structures shall be as follows unless stated otherwise:

Slab (Floor, Roof, Canopy, and Staircase)	30 mm
Shell roof for Filter house	25 mm
Beams (Sides, Bottom & Top)	40 mm
Lintels (all around)	30 mm
Columns	50 mm
Pedestals (in contact with earth)	50 mm
Basement wall, Retaining walls	
i) Face in contact with earth	50 mm
ii) Interior face	40 mm
Foundations	50 mm

2. Liquid retaining structures shall be as follows unless stated otherwise:

Walls – Face in contact with earth	60 mm
Walls – Face in contact with water	60 mm
Base slab in contact with water	60 mm
Base slab in contact with soil	**60** mm
Launders/Gutter slabs	45 mm
Roof slab	45 mm
Manhole	50 mm

i) The cement shall be Ordinary Portland Cement unless otherwise called for by the Engineer, conforming to IS: 8112 or IS: 12269. The cement shall be procured from Ultratech/ACC/Dalmia/Koramandel/Birla. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from the Engineer. Approval for the brand of cement shall be obtained from the Engineer and shall be used though out the project.

j) For reinforced concrete structures, reinforcement shall be HYSD-CRS (Corrosion Resistant Steel) of Grade Fe 500. All physical and chemical properties of this Fe 500 grade steel shall confirm to IS: 1786-2008. Welded wire fabric shall conform to IS: 1566 as shown or specified on the drawing. The CRS (corrosion resistant steel) index shall be at least 1.35 when tested for Salt Spray test as per "ASTM B 117 – 2009 test procedure for 120 hours when compared with the Fe 500 normal reinforcement bars and with same bar diameter. All test results (including physical and chemical properties and salt spray tests) have to be produced for the respective bar diameter for each consignment of steel delivered at site and at a frequency of every 20 Metric Tons.

k) Reinforcement bars and structural steel to be procured only from Primary steel producers/Integrated Steel Plants such as TATA/SAIL/RINL/JSW STEEL/SHYMA using iron ore as the basic raw material and having in-house iron making facilities followed by production of liquid steel and crude steel with in-house rolling, adopting BF-BOF route or DRI-EAF technology as per Ministry of Steel guidelines. No Re-rolled material/secondary steel shall be accepted or allowed for any structural works. The steel manufacturing company should have latest ISO accreditation for Quality Management System.

Only those firms are eligible who are primary steel producer and should have integrated steel plant in single premises.

Certificate issued by ministry of steel of primary steel producer and integrated steel plant having infrastructure in single premises for producing sponge iron, billet and TMT reinforcement bars using iron ore as base material.

l) All buildings shall have a minimum 1 meter wide, minimum 100 mm thick plinth protection paving in M15 grade concrete. Plinth protection shall be supported on well compacted strata of soling about 150mm/ plain cement concrete as required.

m) All pipes and ducts laid below the structural plinth and road works shall be surrounded with concrete of grade M15 having minimum 150 mm thick concrete or D/4 (D = outer dia. of pipe) thickness whichever is more with proper reinforcement.

n) Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.

o) Detailing of the reinforcement shall be considered as per latest Indian code of practices and special publications as applicable.

p) Any structure or pipeline crossing below roads shall be designed for Class A of IRC loading.

q) Sliding layer or slip layer shall be provided between sub base and structural slab (Raft). Polythene sheets of 500 microns shall be provided as sliding layer as per IS specification.

r) Water tightness testing of liquid retaining structures shall be done in accordance with IS: 3370, (Part I) - 2009. It is described in Clause 1.31 of this document. The depth of water for testing shall be upto the soffit of the covering slab.

s) A layer of 300mm thick rubble packing with approved stone, set in regular lines, hand-packed, filling the interstices with approved small stone chips and sand, consolidating by ramming or compacting with heavy roller after watering including spreading of 12mm layer of stone grit on top shall be carried out for all building works below grade slabs/rafts/footings under water logged conditions/high water table conditions.

The following minimum thicknesses shall be used for different reinforced concrete members, irrespective of design thicknesses:

(i)	Walls for liquid retaining structures	:	250 mm
(ii)	Roof slabs for liquid retaining structures (Other than flat slabs)	:	150 mm
(iii)	Bottom slabs/Raft for liquid retaining structures	:	300 mm
(iv)	Floor slabs including roof slabs, walkways, canopy slabs	:	125 mm
(v)	Walls of cables / pipe trenches, Baffle walls/gutter walls, underground pits etc.	:	200 mm
(vi)	Column footings	:	300 mm
(vii)	Parapets	:	100 mm
(viii)	Precast trench cover, Chajja and all fascias	:	100 mm
(ix)	Column Dimension		
	a) Exceptional case (Based on any specific requirement)		
	i) To match with width of block masonry wall	:	200mm

	ii) To match with width of brick masonry wall	:	230mm
	b) In general case	:	300mm
(x)	Beam (To match with width of block masonry wall)	:	200mm
(xi)	Beams (General)	:	300mm
(xii)	Launder Base Slab/gutter slab	:	200 mm
(xiii)	Launder Vertical Wall	:	175 mm
(xiv)	Grade Slabs	:	200 mm

1.17 Materials in General

The term "materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

As soon as practicable after receiving the order to commence the Works, the Contractor shall inform to the Engineer of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of the Engineer which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep the Engineer informed of orders for and delivery dates of all materials.

Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials shall be rejected and shall not be used on any part of the Works under this contract.

1.18 Samples and Tests of Materials

The Contractor shall submit samples of such materials as may be required by the Engineer and shall carry out the specified tests directed by the Engineer at the Site, at the supplier's premises or at a laboratory approved by the Engineer.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer.

The Contractor shall give the Engineer seven days' notice in writing of the date on which any of the materials shall be ready for testing or inspection at the supplier's premises or at a laboratory approved by the Engineer. The Engineer shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by the Engineer to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to Engineer within seven days of every test such number of certified copies (not exceeding six) of the test results as the Engineer may require.

Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's powers under the Contract.

The provisions of this clause shall also apply to materials supplied under any nominated sub-contract.

1.19 Standards

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to the Engineer.
The specifications, standards and codes listed below are considered to be part of this specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between the Specification and the Standards referred to herein, the Specification shall govern.

a) Materials

IS: 383 - Specification for coarse and fine aggregates from natural sources for concrete
IS: 428 - Specification for distemper, oil emulsion, colour as required
IS: 432 - Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (Parts 1 & 2)
IS: 455 - Specification for Portland slag cement
IS: 458 - Specification for precast concrete pipes (with and without reinforcement)
IS: 650 - Specification for standard sand for testing of cement
IS: 651 - Specification for salt glazed stoneware pipes and fittings
IS: 777 - Specification for glazed earthenware tiles
IS: 808 - Specification for dimensions for hot rolled steel beam, column channel and angle sections
IS: 814 - Specification for covered electrodes for manual metal arc welding of Carbon and Carbon Manganese steel
IS: 1003 - Specification for timber paneled and glazed shutters (Parts 1 & 2)
IS: 1038 - Specification for steel doors, windows and ventilators
IS: 1077 - Specification for common burnt clay building bricks
IS: 1398 - Specification for packing paper, water proof, bitumen laminated
IS: 1489 - Specification for Portland pozzolana cement (Parts 1 & 2)
IS: 1566 - Specification for hard drawn steel wire fabric for concrete reinforcement
IS: 1580 - Specification for bituminous compounds for water proofing and caulking purposes
IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement
IS: 1852 - Specification for rolling and cutting tolerances for hot rolled steel products
IS: 1948 - Specification for aluminium doors, windows and ventilators

IS: 1977 - Specification for structural steel (ordinary quality)
IS: 2062 - Specification for steel for general structural purposes
IS: 2140 - Specification for Stranded Galvanized Steel Wire for Fencing
IS: 2185 - Specification for concrete masonry units (Parts 1 & 2)
IS: 2202 - Specification for wooden flush door shutters (Parts 1 & 2)
IS: 2645 - Specification for integral cement water proofing compounds

IS: 2750 - Specification for steel scaffoldings
IS: 2835 - Specification for flat transparent sheet glass
IS: 3384 - Specification for bitumen primer for use in waterproofing and damp proofing
IS: 3502 - Specification for steel chequered plates
IS: 4021 - Specification for timber door, window and ventilator frames
IS: 4350 - Specification for concrete porous pipes for under drainage
IS: 4351 - Specification for steel door frames
IS: 4990 - Specification for plywood for concrete shuttering work
IS: 8112 - Specification for 43 grade ordinary Portland cement
IS: 9862 - Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
IS: 10262 - Recommended guidelines for concrete mix design
IS: 12269 - Specification for 53 grade ordinary Portland cement
IS: 12330 - Specification for sulphate resisting Portland cement
IS: 12709 - Glass fiber reinforced plastics (GRP) pipes, joints and fittings for use for potable water supply

b) Tests

IS: 516 - Method of test for strength of concrete
IS: 1182 - Recommended practice for radiographic examination of fusion - welded butt joints in steel plates
IS: 1199 - Methods of sampling and analysis of concrete
IS: 2386 - Methods of test for aggregates for concrete (Parts 1 to 8)
IS: 2720 - Methods of test for soils (Parts 1 to 39)
IS: 2911 - Code of Practice for design and construction of Pile foundations (Part 4)
IS: 3025 - Methods for sampling and test (physical and chemical) for water and wastewater (Parts 1 to 59)
IS: 3495 - Method of test for burnt clay building bricks (Parts 1 to 4)
IS: 3613 - Acceptance tests for wire flux combination for submerged arc welding
IS: 4020 - Methods of tests for wooden flush doors shutters: Type tests
IS: 4031 - Methods of physical tests for hydraulic cement (Parts 1 to 15)
IS: 5807 - Method of test for clear finishes for wooden furniture (Parts 1 to 6)
IS: 7318 - Approval tests for welders when welding procedure approval is not required (Parts 1 and 2)
IS: 13311 - Methods of Non-destructive testing of Concrete: Part 1 & Part 2

c) Codes of Practice

IS: 456 - Code of practice for plain and reinforced concrete
IS: 783 - Code of practice for laying of concrete pipes
IS: 800 - Code of practice for general construction in steel
IS: 806 - Code of practice for use of steel tubes in general building construction
IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel
IS: 817 - Code of practice for training and testing of metal arc welders
IS: 875 - Code of practice for design loads (other than earthquake) for building structures (Parts 1 to 5)
IS: 1081 - Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators

IS: 1172 - Code of practice for basic requirements for water supply, drainage and sanitation
IS: 1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
IS: 1597 - Code of practice for construction of stone masonry (Parts 1 & 2)
IS: 1742 - Code of practice for building drainage
IS: 1893 - Criteria for earthquake resistant design of structures (Part 1)
IS: 1904 - Code of Practice for Design and Construction of Foundation in Soils :General Requirements.
IS: 1948 - Specification of aluminium doors, windows and ventilators
IS: 2065 - Code of practice for water supply in buildings
IS: 2204 - Code of practice for construction of reinforced concrete shell roof
IS: 2210 - Code for design of reinforced concrete shell structures and folded plates
IS: 2212 - Code of practice for brickwork
IS: 2338 - Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
IS: 2394 - Code of practice for application of lime plaster finish
IS: 2395 - Code of practice for painting, concrete, masonry and plaster surfaces (Parts 1 & 2)
IS: 2470 - Code of practice for installation of septic tanks (Parts 1 & 2)
IS: 2502 - Code of practice for bending and fixing of bars for concrete reinforcement
IS: 2571 - Code of practice for laying in-situ cement concrete flooring
IS: 2595 - Code of practice for radiographic testing
IS: 2751 - Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
IS: 2911 - Code of Practice for design and construction of Pile foundations
IS: 2974 - Code of practice for design and construction of machine foundations (Parts 1 to 4)
IS: 3114 - Code of practice for laying of Cast Iron pipes
IS: 3370 - Code of practice for concrete structures for the storage of liquids (Parts 1 to 4)
IS: 3414 - Code of practice for design and installation of joints in buildings
IS: 3558 - Code of practice for use of immersion vibrators for consolidating concrete
IS: 3658 - Code of practice for liquid penetrate flaw detection
IS: 3935 - Code of practice for composite construction
IS: 4000 - Code of practice for High strength bolts in steel structures
IS: 4014 - Code of practice for steel tubular scaffolding (Parts 1 & 2)
IS: 4111 - Code of practice for ancillary structures in sewerage system (Parts 1 to 5)
IS: 4127 - Code of practice for laying of glazed stoneware pipes
IS: 4326 - Code of practice for Earthquake Resistant Design and Construction of Buildings
IS: 4353 - Recommendations for submerged arc welding of mild steel and low alloy steels
IS: 5329 - Code of practice for sanitary pipe work above ground for buildings
IS: 5334 - Code of practice for magnetic particle flaw detection of welds
IS: 5822 - Code of practice for laying of welded steel pipes for water supply
IS: 7215 - Tolerances for fabrication of steel structures
IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels
IS:10005 - SI units and recommendations for the use of their multiples and of certain other units
SP: 16 - Design Aids for Reinforced Concrete to IS 456
SP: 34 - Handbook on Concrete Reinforcement and Detailing
SP: 38 - Handbook of Typified Design of Structures with Steel Roof Trusses

d) Construction Safety

IS: 3696 - Safety code for scaffolds and ladder (Parts 1 & 2)
IS: 3764 - Safety code for Excavation work
IS: 7205 - Safety code for erection of structural steel work

1.20 General Arrangement of Plant

The following general guidelines shall be followed in the preparation of general arrangement of Plant:

- Sufficient room shall be allowed between components of plant and adjacent Plant or fixed structures to permit safe and convenient access for operation and maintenance.

- An area adjacent to all mechanical Plant shall be provided as maintenance lay down area.

- fixed runways, lifting eyes or other means shall be provided to permit the removal of Plant that may be required to be removed during the course of its normal operational life for maintenance or any other purpose.

- areas where leakage is likely to occur whether in normal use or during maintenance shall be provided with covered drainage channels which shall direct spillage either to a suitable plant drain or to a sump from where it can be pumped to plant drain.

1.21 Orientation

The works shall be laid out within the confines of the Site in order to interface to the existing infrastructure of roadways and inlet and outlet pipe work. Underground services requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of the Engineer, be relocated by the Contractor.

1.22 Buildings and Structures

All the building and structure works shall generally comply with the following Employer's Requirements unless otherwise specified elsewhere.

1. All non-process buildings shall be reinforced concrete framework (Concrete Grade of M25 as a minimum) with RCC roof and covered all around.

2. All building works shall be of reinforced concrete framework.

3. All external walls shall be in solid cement concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision) and shall be 200 mm thick. 75mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry work.

4. All internal partition walls shall be in solid concrete blocks of concrete grade M15 and shall be provided as per IS: 2185 (Latest Revision). All internal walls shall be 200mm thick except for toilets. Toilet partition walls shall be in 100 mm thick solid concrete block.

5. (a) Finishes to concrete liquid retaining structures shall be :
   F1 - External surfaces, buried
   F2 - External surfaces exposed and up to 300 mm below ground level

F2 - Internal surfaces

(b) Finishes to other concrete structures shall be :

F1 - Buried

F1 - Exposed, where plastering is specified

F2 - Exposed

The type of finishes are explained in "Standard Basic Specifications for Civil and Structural Works" in Section 4 of part 10A.

6. All internal masonry and ceiling surfaces finish shall have 12 mm and 6mm thick plain faced cement plaster respectively in cement mortar (1:4) with neat cement finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

7. All external masonry surfaces and concrete surfaces with rough board finish shall have 20 mm thick sand faced cement plaster in two coats, base coat 12 mm thick in cement mortar 1:4 and finishing coat 8 mm thick in cement mortar 1:4. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.

8. All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement-based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

9. Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint.

10. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.

11. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building. Sunken floor shall be provided with water proofing treatment.

12. The flooring in operator's room, security room, loading/unloading bay, MCC cum Panel room shall be in 25mm thick Kota stone slab of approved shade and pattern and placed over 20 mm thick base of cement mortar 1:4 to give overall thickness of 45 mm. Half tile skirting shall also be provided in these areas.

13. The flooring in the pumping stations, chlorination building, workshop, blower room, chemical building, D.G.Room, any other equipment room, etc.., shall be 60mm thick cement flooring with Metallic concrete hardener topping, under layer of 42mm thick cement concrete 1:2:4 (1 cement : 2 coarse : 4 graded stone aggregate 16mm thick nominal size) and top layer of 18mm thick metallic concrete hardener consisting of mix 1:2 (1 cement : 2 stone aggregate 6mm nominal size) by volume & mixed with metallic hardening compound of approved quality @ 3 kg/m^2. Including cement slurry and rounding off edges. In chemical building alum storage area and preparation area, battery room and areas coming in contact with acid / alkali spillage / fume to be provided with Acid resistant tiles. Dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.

14. Existing Chlorine Contact Tank shall be provided with Ceramic glazed floor tiles conforming to IS : 15622 of approved make in colours as approved by the Engineer in charge to be laid on 20 mm thick cement mortar 1:4 (1 Cement: 4 Coarse sand), Jointing with grey cement slurry @ 3.3 kg/m2including pointing the joints with white cement and matching pigment etc., complete.

15. Toilet areas shall have 400 mm x 400 mm x 20 mm thick ceramic non slippery tiles placed in cement mortar 1:4 to give an overall thickness of 50 mm. 2100 mm high dado, in 150 mm x 150 mm x 6 mm thick glazed tiles (approved make, shade and pattern) placed in cement mortar 1:3 shall also be provided in these areas.

16. The flooring along with skirting in administration building shall be 20 mm thick mirror polished, machine cut granite slab of approved shade and pattern placed in cement mortar (1:4). 300mm high skirting shall be provided in these areas. 750mm wide Granite stone shall be provided for laboratory platforms fixed over double sandwiched support as directed and the edges of granite is to be embedded into the wall. Full scale glass windows shall be provided in the control room (from floor to ceiling), in addition to the false flooring and false ceiling.

17. The laboratory shall consist of cupboards/ almirahs/ cabinets made from suitable marine grade waterproof plywood. The floor tiles and dado shall be done with ceramic unglazed vitreous Acid resistant tiles 150mm x 150mm size of approved quality.

18. The toilet facilities shall include at least:
    (i) 2 Nos. Water closets with white porcelain Orissa pan minimum 580 mm long with flushing cistern of 10 liters capacity.

    (ii) 2 Nos. Urinals of sizes 600 mm x 400 mm x 300 mm flat back type in white porcelain separated by a marble partition of size 680 mm x 300 mm.

    (iii) 2 Nos. wash basins of size 510 mm x 400 mm in white porcelain with inlet, outlet and overflow arrangements.

    (iv) 2 Nos. mirror of size 400 mm x 600 mm wall mounted type fitted over wash basins.

    (v) 2 Nos. plastic liquid soap bottles.

    (vi) 2 Nos. Stainless steel towel rails minimum 750 mm long.

    (vii) All stopcocks, valves and pillar cocks shall be in SS

    (viii) All fittings such as `P' or `S' traps, floor traps, pipes, down take pipes etc.

    (ix) The sewage from toilet blocks shall be led to the wet well of terminal sewage pumping station if present under this contract/premises or to the closest gravity sewer or with soak pit with septic tank with necessary arrangements.

19. All staircases shall have granite tiles for treads and risers of approved make and shade and half tile skirting set in cement mortar in 1:4 to be provided. All concrete stairs shall have aluminium nosing over 2 mm thick rubber strip of width same as nosing for the full length of the tread. Nosing shall be fixed with countersunk screws.

20. Stairways shall be provided to permit access between different levels within buildings. Staircase shall be minimum 1200mm wide, minimum Tread = 250 mm, maximum Riser = 175 mm and maximum 15 number of steps per flight unless specified otherwise. Staircases in general shall not be steeper than 40°. The maximum vertical run for a single flight of stairs shall be 3.0 M.

21. All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical step ladders fitted with landing point extensions shall be permitted where considered appropriate by the Engineer to access areas not frequently visited. Steel staircases shall be constructed of standard channel stringers with M.S. grating treads 25mm thick with non-skid nosing. Steel Ladders shall be minimum 600mm wide and shall not exceed 6m of straight and shall be painted with epoxy paint. PVC encapsulated Cast Iron rungs or step shall be provided on the inner side walls of all the liquid retaining structures at 300mm spacing.

22. Admin building hand railing shall be provided with SS 304 grade of 50mm dia. (top) 14 gauges hallow pipe. The minimum height of hand railing shall be 1.2m and maximum spacing of verticals shall be 1.2 m. with 50mm dia. Number of horizontal rails shall be 3 nos. of 40mm dia. at top and 25mm dia. (1 intermediate and 1 bottom) with a 100 x 10 toe plate at the bottom.

23. All hand railing shall be retained by the contractor, any damage during up-gradation and wherever required shall be provided with same type and material as existing.

24. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane brick bat coba/ Yelahanka tiles. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W down take inlet points.

25. All roof floors shall have minimum 750 mm height solid concrete block parapet wall.

26. For roofing drainage, uPVC 6kg/sqm rainwater down takes with Bell mouth and uPVC grating at top shall be provided. For roof areas up to 40 sqm minimum two nos. 110 mm diameter down take pipes shall be provided. For every additional area of 40 sqm or part thereof, at least one no. 110 mm dia. down take pipe shall be provided.

27. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water. All chajjas and canopies shall be provided with drip moulding.

28. Building plinth shall be minimum 450 mm above average finished ground level around building or high flood level whichever is more. Damp proof course shall be minimum 75mm thick in CC 1:3:6.

29. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building. Chajja projection of minimum 750 mm for rolling shutters, 600 mm for doors and 600 mm for windows shall be provided to prevent the rain water splashing into the building. Chajja shall be projected 300 mm on either side from size of doors/windows/rolling shutters.

30. All windows and ventilators shall have 20 mm thick ceramic tiles sills bedded in cement mortar (1:3).

31. All Aluminium Doors, windows and Ventilators sections shall have powdered coated to a minimum of 60-70 microns with exterior durable polyester grade powder of approved quality.

32. All doors except main door for Admin building, windows and ventilators shall be made of aluminium confirming to latest version of IS: 1948. All fixtures for doors, windows and ventilators shall also be of aluminium and shall be provided as per IS specifications. Aluminium grills shall be provided in all the windows. Doors shall be in single panel and panels shall be glazed/unglazed. Minimum weight of aluminium doors & windows shall be as follows:

I. Single Glazed Window: (Weights indicated shall be aluminium)

a) Openable

Outer Frame	:	Weight 0.70 kg/Rmt
Shutter Frame	:	Weight 0.97 kg/Rmt
Intermediate Mullion	:	Weight 0.97 kg/Rmt
Beading	:	Weight 0.31 kg/Rmt

Fixing Louvers windows/ventilators

Outer Frame	:	Weight 0.46 kg/Rmt

II. Double Glazed Window

Outer Frame	:	Weight 0.72 kg/Rmt
Shutter Frame	:	Weight 0.97 kg/Rmt
Intermediate Mullion	:	Weight 0.98 kg/Rmt
Beading	:	Weight 0.31 kg/Rmt

III. Sliding Windows

Bottom & Top Frame	:	Weight 0.70 kg/m
Shutter Frame	:	Weight 0.42 kg/m
Interlocking Section	:	Weight 0.47 kg/m

IV. Aluminium Door

Outer Frame	:	Weight 2.508 kg/Rmt
Shutter Frame	:	Weight 2.508 kg/Rmt
Bottom Stile	:	Weight 2.508 kg/Rmt

Glazing shall be 5.5wired mm thick glass.as per IS: 2835 for doors and windows.
Glass louvers shall be provided for ventilators with frame weight of 0.46kg/Rmt

Main door for admin building shall be wooden door and as approved by the engineer.

33. Openings of the windows & ventilators shall be minimum 25% of the external wall area.

34. Ventilator shall also be provided where height of floor is more than 3m.

35. All windows and ventilators shall have wire mesh. Frame of doors, windows and ventilators shall be of aluminium of standard rolled section. Doors, Windows and Ventilators shall be of size as per schedule to be submitted by the Contractor for approval of Engineer. The minimum size shall be as per below:

Door of opening size 1.2m x 2.1m
Door of opening size 0.75m x 2.1m for toilets
Glazed windows of minimum size 1.2m x 1.2m
Ventilators of minimum size 0.6m x 0.6m

36. Rolling shutters shall be made of 80 x 1.25 mm MS laths. Rolling shutter shall be of minimum size 3.0m wide x 3.0m high. Rolling shutter shall be provided in MCC cum panel room, chlorine tonner shed, and at entry and exit of the pump house for access to pumps, motors, valves, panels, blowers and as wherever required. Up to 3m height mechanical operated rolling shutter shall be provided and If the height is more than 3m, then electrically operated rolling shutter shall be provided.

37. All structural steel members shall be painted with two coats of enamel paint over one shop and one field coat of red oxide zinc chrome primer. All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with same type and material as existing to a minimum height of 1.2 m from the access surface elevation.

38. All exposed surface of inserts embedded in concrete shall be painted with two coats of enamel paint over one coat of Red Oxide Zinc Chrome Primer. Surface in contact with concrete shall not be painted.

39. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act. It shall not be less than 150mm.

40. All structures in the Treatment plant units shall be provided with appropriate sign boards indicating the function of the units involved written in Kannada and English Languages.

41. The roof of the buildings shall be provided with Solar Panels of approved make as per approval of Employer for sustainable development and meeting basic lighting system load from solar power.

42. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry of **minimum capacity of 2 tonnes** or more as required shall be provided with monorail and operating equipment.

43. The design of buildings shall reflect the climatic conditions existing on site. Process buildings shall as far as is possible permit the entry of natural light, and the use of glazed panelling shall be kept to a minimum and preference given to wall openings protected by weather canopies.

44. Emergency exit doorways shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.

45. Toilet blocks in process buildings and control blocks shall be provided with a sink with two drinking water taps of 20 mm size with adequate inlet and outlet connections.

46. The side walls of buildings shall, except those used for storage and handling of Chlorine gas comprise at least 25% ventilated brickwork or louvers. Ventilated brickwork or louvers shall not be used where the ingress of driven rain could affect plant or stored materials. Flat roofed areas shall be provided with roof vents to further encourage a through flow of air.

47. All the walkways shall have minimum 1.2 m width and shall be covered with precast, pre polished cement concrete designer tiles. Walkways to be provided with SS Handrails and toe guards.

48. Suitable River flow training systems/Flow diversion to be adopted at required locations in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

49. All concrete structures in contact with sewage and/or sludge shall be provided with full interior corrosion protection linings and/or coatings of appropriate material and thickness to be approved by Employer. For Aeration Basins, interior lining shall extend from the top of wall down to 1.0 meter below the lowest operating water level.

50. For structures containing water or process liquid, the top of the wall shall be at least 0.5m higher than the maximum water surface level calculated at high flood level and peak plant flow. The top level of internal plant roads and approaches shall be at least 0.5 m above the site High Flood Level.

51. If the High flood level is more than Ground Level, then road shall be constructed on the Earthen Embankments/Engineered Embankment. Earthen Embankments/ Engineered Embankment shall be constructed with side slope of at least 2 horizontal to 1 vertical. Stone pitching shall be provided at both sides of the embankment as per IS: 8237. Top width of embankment shall be taken as 6.0m. Top level of embankment shall be 0.5 m above high flood level. The excavated earth from the plant can be used for earthern embankment construction if suitable and if required extra earth can be borrowed from the borrow pit as approved by Engineer.

52. Anti-termite treatment, under and around the column pits, walls, trenches, basement excavation, top surface of the plinth filling, junction of wall and floor, along the external perimeter of building, expansion joints, over the top surface of consolidated earth on which apron is to be laid, surrounding of pipes & conduits, with chloropyriphos emulsifiable concentrates of 20% concentration is to be provided for this only plinth area of the building at ground floor only shall be measured.

53. Engineered Embankment for plant structure in Swampy/Water logged areas shall be considering in compliance with relevant Geotechnical Investigation Report recommendations as applicable.

54. All requirements for Engineered Embankment and all other associated works connected to this system (i.e. all controlled filling requirements, type & suitability of materials, methodologies testing, protective system, aprons, proper slopes, stability, specifications, quality control, and all other requirements pertaining to this system of works, etc.,) shall be considered in compliance with relevant geotechnical investigation report recommendation as applicable. Also, to enlist the service of an experience and specialized agency for all related design aspect consideration, equipment specifications, and implementation methodology, etc., as an advice for the same.

1.23 Roadways, Pathways & Hard standings

A comprehensive network of roadways with turning bays as required for access, removal of plant and equipment, removal of sludge, grit etc. from site shall be provided around the treatment plant to link in

with the existing road network and permit access to the plant for necessary maintenance, delivery of consumables and personnel access.

All roads shall be designed and constructed of Wet Mix Macadam as per the specifications and as per engineers requirements. Bidder shall provide minimum 5m wide internal roads at STP and 5m wide internal road for ISPSs excluding shoulders and drains. Two side drains shall be provided as per site requirement and as directed.

The road works shall be designed and constructed as per MORTH guidelines and specifications. The minimum road layers shall consist of granular sub base, sub grade, wet mix macadam (2 layers with compacted thickness of 150 mm), semi dense bituminous concrete, bituminous macadam and Bituminous concrete as per the design requirements. All roads shall be provided with drainage and shall be constructed to prevent standing water.

Paved pedestrian access ways of 3m width shall be constructed with interlocking concrete blocks of 40mm minimum thickness to provide a network of logical routes interlinking plant areas. Damage to any existing roads on account of their use by the Contractor shall be made good to the satisfaction of the Engineer.

Hard standing areas with shading facility shall be provided to permit the parking of vehicles involved in the delivery of consumables from blocking site roadways during unloading or loading. The road system shall be designed such that vehicles involved in the delivery of consumables can follow a continuous route through the works and out again without the need to reverse or carryout complicated manoeuvres in order to exit the site.

1.24 Site Drainage

The Contractor shall provide a site drainage system. The system shall comprise of the following:

- Storm Water Drainage
- Foul Drainage
- Process Drainage

1.24.1 Storm Water Drainage

For the major storm water drains passing besides or within the STP complex shall be designed as per CPHEEO requirements considering the contributing catchment area. Necessary cross drainage works shall be provided for road crossing etc. If the existing storm water drain is passing through the center of the STP area, the storm water drainage alignment shall be diverted along the edge of the STP complex area for proper usage of the STP area.

For the internal storm water drains adjacent to the existing and proposed roads (under the contract) shall be sized for a rainfall intensity of 50 mm/hr, allowing for 100% run off. The drains adjacent to roads for walls and floor shall be in RCC M 25 grade. The floor is to be laid over a minimum thickness of 10 cm thick 1:3:6 PCC bed and the drain is to be covered with M 25 grade RCC slab. The minimum width of the drain shall be 450 mm. The storm water drainage system shall also be designed to cater the run off from the existing plot areas and structures, if necessary depending upon the site topography.

The storm water drainage system shall also be designed to cater the run-off from the existing plot areas and structures, if necessary depending upon the site topography.

All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, pre cast RCC covers shall be provided in place of steel grating. These drains shall lead the water to drain sump.

Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.

1.24.2 Foul Drainage

The foul drainage system shall accept discharge from toilets, washrooms, offices and the laboratory. The foul drainage system shall be conveyed to the existing terminal sewage pumping station exist inside the STP premises.

1.24.3 Process Drainage

Where ground water/Nallah surface flow is encountered or anticipated the contractor shall provide sufficient pumps to handle the ingress of water and must provide and maintain in working order. Standby pumping units are to be made available and employed in the event of mechanical failure. The contractor must also arrange for night and day operation of the pumps wherever necessary to ensure that the work proceeds at all times**.**

1.25 Cable and Pipe work Trenches

Cable and pipe work trenches shall generally be constructed in reinforced concrete.

All floor cut-outs and cable ducts, trenches within the buildings or Plant areas shall be covered with M25 precast R.C.C covers (heavy duty) or MS grating as per direction of Engineer in outdoor areas and MS chequered plates, suitably painted of adequate thickness in indoor areas. The trenches shall be suitably sloped to drain rain water. All uncovered openings shall be protected with hand railing.

Layout of trenches outside the buildings shall allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of the Engineer while planning the works.

1.26 Pipes and Ducts

R.C.C ducts for drainage shall have minimum 1 meter over precast cover (M25 concrete, Heavy duty) while laid under roads. Access shafts of size not less than 600 mm x 1000 mm shall be provided.

All drains (except storm water drains adjacent to roads) shall be covered with precast RCC slab and designed structurally for appropriate loads.

1.27 Landscaping

The site shall be landscaped once the Works are substantially complete. Landscaping area shall be marked in layout plan.

Landscaping shall include planting of suitable trees and development of grassed areas with sprinkler system with associated piping system. Landscaping in general shall meet ecological and environmental conditions of the site. Road widths shall determine the size of the tree height and spread to be selected

for planting. Trees suitable for local conditions shall be selected as approved by the Engineer. Medicinal and fruit trees shall be avoided. Landscaping shall be maintained in good condition till the completion of contract. Area for landscaping shall be equal to total area of project site minus area for the Treatment plant units and the area required for roads, sidewalks and drains.

1.28 Tree Planting

Pits dug a few days in advance of actual planting shall be allowed to weather and be filled with top soil mixed with manure. Size of the pit shall be as per standard requirement. Only one tree shall be planted in each pit. A guard made of bamboo with wire mesh or bricks or M.S. rings as approved by Engineer shall be provided. All trees shall be maintained upto the end of O & M period.

1.29 Hydraulic Testing of Liquid Retaining Structure

In addition to the structural test of structures as applicable, the liquid retaining structures shall also be tested for water tightness test at full supply level as described in clauses 10.1, 10.1.1, 10.1.2 and 12.1.3 of latest version of IS 3370 (Part I).

On completion of the structure and before its commissioning, the contractor shall carry out a water tightness test for the maximum water head condition i.e. with the water standing at Full Supply Level (FSL) of the structure. This test shall be carried out preferably in dry season in accordance with the procedure given below:

The water tightness test shall be carried out when the construction of liquid retaining structure is completed and when it is possible to fill the structure and ensure that uniform settlement of the structure as a whole or as directed by the Engineer. Before the filling operations are started the structure shall be inspected by the Engineer and the Contractor's Representative and the condition of surfaces of walls, contraction joints shall be noted and it shall be ensured that the jointing material filled in the joint is in position and all openings are closed. The Contractor shall make necessary arrangement for ventilation and lighting of the structure by way of floodlights, circulators etc. for carrying out proper inspection of the surfaces and inner conditions if so desired by the Employer. Records of leakages starting at different levels of water in the reservoir, if any, shall be kept.

The liquid retaining structure once filled shall be allowed to remain so for a period of seven days before any readings of drop in water level are recorded. The level of the water shall be recorded against the subsequent intervals of 24 hours over a period of seven days. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the structure, which for all practical purposes shall not exceed 40 mm. Also there shall be no indications of the leakages around the opening or on the walls.

If the structure does not satisfy the condition of test and the daily drop in water level is decreasing, the period of test may be extended for a further period of seven days and it the specified limit is then reached the structure may be considered as satisfactory.

The external faces of structure shall not show any signs of leakage and shall remain apparently dry over the period of observation of seven days after allowing a seven day period for absorption after filling.

In case the drop in level exceeds the permissible level limit and signs of leakage with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Engineer to reduce the leakage within the permissible limits. The entire rectification

work that shall be carried out in this connection shall be at the Contractor's cost. Contractor shall have to make arrangement for filling emptying the structure at his own cost.

If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the liquid retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure shall be condemned and the Contractor shall dismantle and reconstruct the structure, to the original specification, at his own cost.

During testing and during defect liability period the impression marks created due to seepage shall be rectified and made good.

No separate payment shall be made for water tightness test and the cost thereof shall deem to be covered in the rates quoted for the works.

1.30 Non-Destructive Testing of RCC Structures

Non-Destructive Testing (NDT) shall be carried out as per latest IS: 13311 codes as per the instruction given by Employer.

Commonly used NDT to find quality, structural integrity and soundness of in-situ concrete are:

1. Rebound Hammer Test is a qualitative field test method to measure surface hardness of concrete to find insitu concrete strength.

2. Ultrasonic Pulse Velocity (UPV) Test is a qualitative field test method for determination of discontinuities, cracks and depth of cracks of concrete.

3. Core cutting/Sampling Test is a field cum lab test for assessment of strength, density, texture and permeability of concrete.

4. Radiography Test for taking photographs showing details inside of concrete member, where other NDT methods are not suitable.

5. Impact Echo Test is a filed/laboratory test method to detect hidden damage and its extent.

In case there is any distress in concrete during the execution, Engineer can take decision to go for NDT on the RCC construction before taking any action. Contractor shall conduct NDT tests on his own cost.

1.31 Specification for Anti-Corrosive Internal Coating/Lining protection of Concrete Surfaces

Application limits of Anti-Corrosion Internal Coating/Lining for Concrete Surfaces:

1. All units upstream of secondary treatment units shall have to be provided with internal coating/lining for the full internal surface area (Walls and base slab).

2. For the units - Aeration Zone, Anoxic Zones, De-aeration Zones and Aeration Basin Effluent Channels, internal coating/lining shall be provided on the walls only from the top of the structure to 1.0 m below the lowest operating liquid level

3. For the units handling the solids part such as Sludge sumps, and all other units, internal lining shall to be provided for the entire internal surface area.

Contractor shall adopt any one of the following materials for internal coating/lining which should be grey coloured, **solvent free**, machine sprayed, resistant to water and chemicals, good bond between concrete surface and lining/coating material and submit his methodology for approval of Engineer. No signs of swelling, scratches or peeling of coating specimen shall be observed after application of coating or lining.

Concrete Structure- Surfaces must be clean, dry and free from curing compounds, laitance, releasing compounds, oil, grease, dirt, chalk, or previously applied coatings. Laitance must, therefore, be removed by sweep blasting or other means prior to coatings application. Ensure that the concrete is sufficiently dry to receive coatings; use a moisture meter. The 6% maximum moisture content shall be permissible. A minimum surface thickness of 500 microns is recommended.

Steel Structures- All surfaces to be coated must be clean and free from dust, grease, oil or loose material. A minimum surface profile of 50- 75 microns is recommended.

Below are some of the vendor products accepted. However, the process and application requirements shall be matched and got approved from the engineer in charge before start of work for the products and vendors mentioned below. Also, if any new material and vendor can meet the process requirements, as stated above, the Engineer in charge shall approve the material specifications by the manufacturer.

Sl. No.	Approved Vendor	Approved/Appropriate product
1	Sika India Pvt. Ltd.	Intertol Poxitor
2	STP Limited	Shalipoxy – CTE 406
3	BASF Construction chemicals	MasterSeal – 7000CR
4	Fosroc	Nitocote NT402
5	International - PC	Interzone 954

1.32 Rain Water Harvesting System

The Rain water harvesting for the proposed STP shall be carried out in line with the regulatory guidelines specified by Bangalore Water Supply and Sewerage Board (BWSSB) & GOK norms.

1.32.1 Need for Rain Water Harvesting

Rainwater harvesting at STP site shall be carried out in view of the following

a) Conserving rainwater
b) Possibility of integrating the storm water drainage scheme of the STP with rain water conservation.

The convenient and economical way of achieving the same is by adopting roof water harvesting methodologies.

1.32.2 Components of the Rain water Harvesting scheme

1. Rainwater harvesting carried out for enriching the groundwater resources essentially consist
    a) Common collection tank and
    b) Pipeline(s)

2. Following are the main components proposed for the roof water harvesting system at the STP including their location in the project area:
    a) Rainwater pipes from the roofs of all the building.
    b) First flush piping system.
    c) Storm water drains adjoining the roads of the plant.

1.32.3 Rainwater harvesting system for buildings

The run off from the roof top of all buildings shall be collected to a RCC sump at suitable location in the plan area with a minimum water retaining capacity of 40Cum. The minimum height of the sump shall not be less than 1.8m and 0.3 m free board. The runoff shall pass through suitable filters for removal of impurities. A suitable submersible pump shall be provided in the sump for supplying water to gardening and flushing the toilets, to reduce use of potable water.

1.32.4 Rainwater harvesting system for plant area

The runoff from internal road side drain and major plant are shall be drained to rainwater harvesting structures for ground water recharge.

End of Part 10B